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AD-E403 310

Technical Report ARESI-TR-10001

# **NATIONAL SMALL ARMS CENTER (NSAC) INAUGURAL FIVE-YEAR OTHER TRANSACTION AGREEMENT**

**SUMMARY REPORT FY05 THOROUGH FY09**

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# 20101214123

November 2010



**U.S. ARMY ARMAMENT RESEARCH, DEVELOPMENT AND  
ENGINEERING CENTER**

**Munitions Engineering Technology Center**

**Picatinny Arsenal, New Jersey**

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<b>REPORT DOCUMENTATION PAGE</b>				<i>Form Approved</i> <b>OMB No. 0704-01-0188</b>	
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1. REPORT DATE (DD-MM-YYYY) <b>November 2010</b>		2. REPORT TYPE		3. DATES COVERED (From - To) <b>12/2004 to 9/2009</b>	
4. TITLE AND SUBTITLE  <b>NATIONAL SMALL ARMS CENTER (NSAC) INAUGURAL FIVE-YEAR OTHER TRANSACTION AGREEMENT</b>  <b>Summary Report FY05 through FY09</b>				5a. CONTRACT NUMBER	
				5b. GRANT NUMBER	
				5c. PROGRAM ELEMENT NUMBER	
6. AUTHORS  <b>Frank P. Puzycki</b>				5d. PROJECT NUMBER	
				5e. TASK NUMBER	
				5f. WORK UNIT NUMBER	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) <b>U.S. Army ARDEC, ESIC</b> <b>Joint Small Service Arms Program Office (RDAR-EIJ)</b> <b>Picatinny Arsenal, NJ 07806-5000</b>				8. PERFORMING ORGANIZATION REPORT NUMBER	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES) <b>U.S. Army ARDEC, ESIC</b> <b>Knowledge &amp; Process Management (RDAR-EIK)</b> <b>Picatinny Arsenal, NJ 07806-5000</b>				10. SPONSOR/MONITOR'S ACRONYM(S)	
				11. SPONSOR/MONITOR'S REPORT NUMBER(S) <b>Technical Report ARESI-TR-10001</b>	
12. DISTRIBUTION/AVAILABILITY STATEMENT  <b>Approved for public release; distribution is unlimited.</b>					
13. SUPPLEMENTARY NOTES					
14. ABSTRACT  <b>This report summarizes the first 5-yr history of the National Small Arms Center. The report documents technical achievements, lessons learned, and other management/process information to serve as an historical record of this unique organization's start-up and maturation path.</b>					
15. SUBJECT TERMS  <b>Consortium, Innovation, Small arms, Joint Service Small Arms Program, National Small Arms Center, National Small Arms Technology Consortium</b>					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT  <b>SAR</b>	18. NUMBER OF PAGES  <b>37</b>	19a. NAME OF RESPONSIBLE PERSON <b>Frank P. Puzycki</b>
a. REPORT <b>U</b>	b. ABSTRACT <b>U</b>	c. THIS PAGE <b>U</b>			19b. TELEPHONE NUMBER (include area code) <b>(973) 724-6081</b>

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## INTRODUCTION

### Report Purposes

This report documents the first 5 yrs of the Other Transaction Agreement (OTA) between the National Small Arms Center (NSAC) at the U.S. Army Armament Research, Development and Engineering Center (ARDEC), Picatinny Arsenal, New Jersey and the National Small Arms Technology Consortium (NSATC). The period of execution covers the fiscal years (FY) 2005 through 2009, although the initiation, planning, and start-up predate that period by almost 18 months. The report is intended to be a public release document; accordingly, it will not delve into detailed programmatic substance. Rather, it is intended to serve as a reference framework from which interested parties can pursue more detailed investigation and analyses.

### Consortium Intents

A fundamental question arises in preparing this document; viz; what if anything is broken in the current research, development, and acquisition process that requires such a construct to be introduced into the United States small arms field? By most metrics, the current small arms acquisition process is disciplined, structured, coordinated, and productive. The presence of a Joint Service Small Arms Program Office (JSSAP), created in 1978, serves as just one measure of the vitality of the extant process. A bit of research into the origins of the OTA acquisition instrument, forging the ties between the NSAC/NSATC, provides at least part of the impetus for creating this new partnership.

The Defense Advanced Research Projects Agency first proposed the creation of the OTA in the late 1980s in response to the concern that the Federal government was increasingly being marginalized in the high tech revolution of that period due to its Federal Acquisition Regulation (FAR) driven procurement process. The FAR process did not ordinarily permit the United States Government (USG) to respond in a timely manner, at least as quickly as the emerging "dot.com" entrepreneurial start-up firm's accelerated business model demanded. These cutting edge firms produced technologies and applications whose half-life easily exceeded a normal FAR based acquisition timeline. To add to that mismatch, firms jealously guarded their intellectual property as the core of their business viability; the FAR-based presumptive intellectual property provisions served as a further detriment to collaboration with the USG. Congress enacted the alternative OTA-based legislation in anticipation that its provisions would sustain the Government's participation and access into the market place. The Congress also clearly anticipated that substantive innovation would result by its application to Federal product and service requirements.

The NSAC/NSATC collaboration is focused on producing that form of complementary innovation in the national small arms field differentiating itself from the more main stream requirements-driven acquisition process of the joint and individual services. Specifically, the NSAC assumes a supplier-driven (push) interaction as opposed to the FAR-based customer (pull) relationship ordinarily resulting from the FAR process. That differentiation is critical to assuring that this new construct avoids costly and meaningless redundancy to its mainstream requirements-driven counterpart. This document will seek to underscore that difference to its readers repeatedly.

## Report Structure

The report's subsequent sections are ordered in the following format and structure to serve as the intended framework described previously:

- **Executive Summary:** Provides a concise narrative emphasizing achievements, issues, challenges, and a future roadmap. It should be viewed as a capsule lessons learned section.
- **History:** This section provides the deeper context as to the NSAC/NSATC's origins in order to substantiate the practical necessity and imperative to form such a complementary alliance of suppliers and customers.
- **The Broad View:** This section seeks to make the case for the value-added nature of the NSAC/NSATC by generically discussing the meaningful and impactful outcomes created by the OTA-driven initiatives originating from this partnership.
- **Unresolved Issues:** Like most new initiatives, this undertaking has experienced its share of start-up problems and challenges. This section provides a capsule summary of those issues as a prelude to the final section of this document.
- **The Future:** This section charts a general path forward. The reader, armed with the context of the prior sections, can now readily appreciate the timeline and strategy for the renewed OTA.
- **Year-by-year Capsule Summary:** A chronological, albeit brief summary of the Center's evolution in order to both document progress and to serve as a lessons learned for the stand-up of future military-based consortia. Each year is described in the appendix.

## EXECUTIVE SUMMARY

### Achievements that Made a Difference

The NSAC awarded 45 separate actions, the majority of which were task order sub-agreements totaling over \$17.9 million dollars. As will be depicted in later sections of this report, the award structure can be parsed chronologically and programmatically into various categories. Initial awards were made against the following three thrusts.

#### Lubeless Weapons

Attempts were made to define dry lubrication systems to replace the more traditional wet-oil based formulations routinely applied in United States small arms. This investigation reflected the continued trend of United States forces operating in desert-like conditions in which these extant wet lube agents tended to attract and retain the sand-like constituents of that part of the world.



## **Lightweight Ammunition**

The war fighter has persistently advocated measures to reduce the combat load of the individual soldier to counteract the added burden of equipment and gear which provide improved protection, detection, etc. Ammunition constitutes one major avenue to effect such weight reductions through employment of lower density alternatives to brass for cartridge casings.

## **Reduced Recoil Systems**

Recoil is a major contributor to inaccurate fire, especially in the individual weapon class of firearms. With the advent of larger caliber anti-material sniper rifles, this need became accentuated.

The focus of the NSAC annual program shifted in FY07 as the impact of a Joint Capability and Integrated Development Systems (JCIDS) requirements process emerged in its application to small arms systems planning. This change of emphasis was encapsulated into multiple technology thrusts areas which in turn were prioritized by war fighter needs. The first two such categories have occupied most of the NSAC's formal annual program thrusts since FY07.

## **Enhanced Lethality**

Technologies related to increasing the terminal performance of small caliber munitions that include bullets and warheads. This area of investigation also includes new and non-traditional applications of small arms projectiles such as surveillance and information gathering.

## **Advanced Tactical/Technical Fire Control**

This is technology that enables units to optimally engage threats with their weapons and effects in a combinatorial employment to overwhelm the short duration threat targets while expediently dominating the battle space. These technologies address the detection, identification, and acquisition of targets including range, weapon/platform state, and ballistic solution determination for individual and crew served weapon system's dynamic application of forceful effects.

Intermingled with the specification of these generic but defined technology opportunities was the establishment of the pure supplier-push, open-ended list of general and Product Manager "areas of interest" categories allowing members to advance their own small arms capability concepts under a different solicitation form ultimately titled the Request for Business Development Proposal (RBDP). Requested by the NSATC industrial base segment of membership, the RBDP permitted submission of full scale proposals without any reciprocal fiscal obligation on the part of the USG. Since its inception, this solicitation type has been amply used by the war fighter and Product Manager communities to identify new products and capabilities not previously on the service's active requirements list.

To date, there have been three significant achievements that highlight the utility of this consortium and the ability to produce innovative products and capabilities. These three accomplishments are described next.

## **Lightweight Stainless Steel Cases**

Fleximation, a one person company, responded during the inaugural solicitation claiming that stainless steel represents an economically viable, low weight alternative to cartridge case brass. This firm partnered with SNC Corp to successfully demonstrate processing as well as functional feasibility for this concept in the 7.62-mm caliber. That demonstration provided empirical verification through extensive function and casualty testing in standard United States weapon systems. This initial feasibility has subsequently spurred investigation into the 5.56-mm service grade ammunition as well as blank ammunition in both of these calibers. The use of such an alternative process offers potentially simpler manufacturing techniques, which in turn are more environmentally friendly. This development also offers the potential to enlarge the availability of the United States manufacturing base of ammunition production by employing the sheet metal stamping industry as a new supplier source.

## **Luminescent Tracer**

Tracer ammunition processing is a complex manufacturing regimen requiring close control and attendant scrutiny. Design of tracer projectiles to provide functional trajectory matching to service grade ball ammunition can also pose significant challenges to the small arms designer. The University of Louisiana of Lafayette, in an in-house development effort, conceived and produced initial samples of a flameless luminescent tracer projectile. This approach uses the service grade bullet design greatly simplifying the ballistic match tradeoffs inherent in current tracer design technology. It offers a new unique signature characteristic that has resulted in the user designating luminescent tracers as a "tracking" projectile. The enhanced war fighter interest in this alternative has recently accelerated this concept to full developmental status.

## **Small Arms Thermal Modeling**

As an outgrowth of the United States Marine Corps (USMC) Infantry Automatic Rifle competition (whose phase one prototypes were produced through the NSAC solicitation process), Knights Armament Company advocated an intensive thermal modeling development program in order to provide enhanced design and innovative analysis capabilities for this critical functional parameter. Two generations of development have produced initial predictive models offering increasing fidelity to subsequent live fire assessments.

## **Administrative/Fiscal/Technical Challenges**

From its inception, the NSAC has faced numerous challenges owing to the nature of its business and product areas, the severe strain placed on the Army's acquisition assets (owing to the nation's war time footing), and the NSAC's international scope of membership and activities. These challenges have served to modulate its progress and maturation and altered its goals in both subtle and overt ways. A capsule summary follows.



## **Fiscal**

At the outset, a significant portion of the JSSAP funding lines were committed to a few on-going programs. That condition dictated an initial reliance on other people's money in the form of Product Manager investment and other Congressionally mandated efforts. Over time, the dependence on those pools of funds has lessened such that a more balanced ratio now exists. What remains as a major challenge, however, is the creation of dedicated "sandbox" funding. That type of resource pool are monies not specifically targeted to approved programs but rather to serve as "seed" money sources to launch industry/academe "push" type programs that offer potential innovations beyond extant user identified needs and interest areas.

## **Administrative**

The Army's professional acquisition workforce has been severely strained by a "perfect storm" confluence of two demographic influences. The Army has shouldered a significant burden of the nation's current prosecution of the war on terrorism, making it highly difficult for the relatively modest NSAC budget/program to compete for priority versus a myriad of other formal procurement initiatives. Aggravating that condition is the onset of baby-boomer retirements during this same period resulting in less seasoned personnel assimilating more responsibility and workloads than would ordinarily occur. The resulting impact on the NSAC procurement agenda has been substantial, including inordinate delays in procurement cycles especially during the FY07 to FY09 timeframes. The nascent Army Contracting Command's forecast of a 4-yr transition period to alleviate this problem has prompted the NSAC to redirect its procurement program, on an interim basis, to the National Business Center's Sierra Vista's division (within the Department of the Interior) beginning in FY2010.

## **Technical**

Besides the aforementioned tech base funding restrictions experienced during the initial FY05 and FY06 periods, the evolution of the foundational JCIDS baseline requirements effort, [later to morph into the Capabilities Based Analysis (CBA)] delayed introduction and implementation of a needs-based framework from which member's could intelligently craft innovative proposals and solutions. Since 2008, this condition has significantly abated resulting in higher quality white paper and proposal submissions.

## **Future Directions/Prognosis**

The achievements and challenges summarized previously have altered the original intent of this effort, but have not surprisingly diminished its original envisioned potential. Most encouraging is the continued upward trend in terms of both the quality and impact of member proposals and white papers. Recent Office of the Secretary of Defense (OSD) guidance regarding the implementation of the OTA agreement option is forcing the industry/academe leadership to reassess the current NSATC structure and associated member/USG relationship. A so-called single-point entity structure is currently under consideration in response to this new guidance which could potentially impact the resource base and contracting strategy currently in place. Lastly, the NSATC's Business Development Committee (BDC) likewise has gained traction in recent months (2009), which may ultimately translate into creation of the much needed sandbox funding pool that could launch rigorous small arms innovations in future decades.

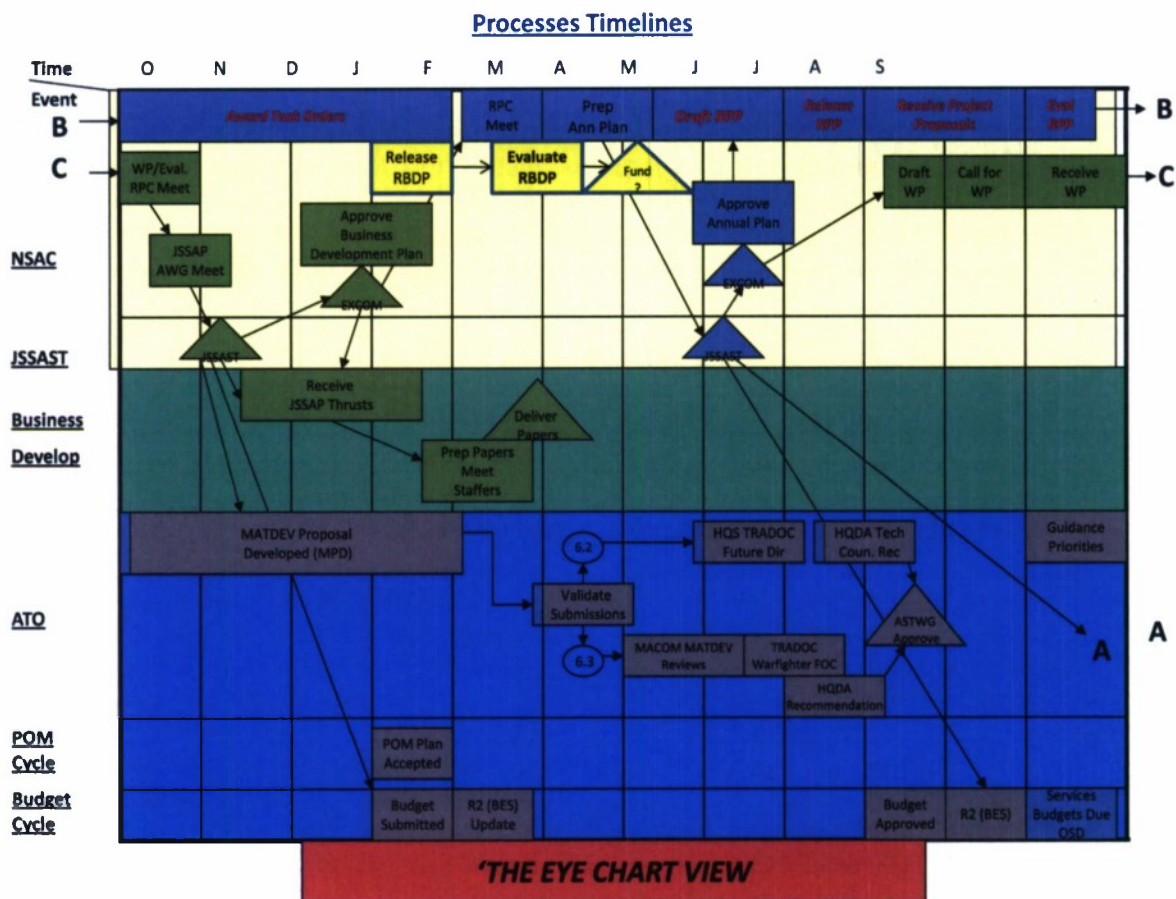
## A BRIEF HISTORY

There were two main influences that drove the creation of the NSAC and NSATC. The Committee for Small Arms Producers (CSAP) established by Jimmy Morgan at Rock Island Arsenal (RIA), sought to establish closer ties between suppliers and customers within the small arms field. The RIA's emphasis principally centered on production support, but ARDEC also had a seat at this table in the person of the Senior Technical Executive for the Close Combat Armaments Center. During the early 2000s, Kevin Fahey occupied that position. He has previously served in the PEO Ammo organization and has been keenly aware of the Defense Ordnance Technology Consortium (DOTC) established at ARDEC for large and medium caliber munitions. He saw a need for the same type of impetus within small arms to supplement the established JSSAP program as a supplier push complement. Ultimately, the standup responsibility for the NSAC fell to the JSSAP office. The JSSAP in turn contracted with Engineering Management Executives to explore the feasibility of creating an NSAC and by September 2003, a formal meeting took place with 27 charter members at the Hilton Garden Inn, Rockaway, New Jersey.

While the DOTC can be considered the organizational template for the NSAC, there are two significant differences. The NSAC has an international membership reflecting the nation's small arms strategy for the past 30 yrs wherein foreign weapon designs have entered the United States inventory in the cases of the M249 squad automatic weapon, the M240 medium machinegun, and the 9-mm Beretta pistol. This multinational constituency requires high scrutiny management of the critical information management process, an aspect to be discussed in more detail later in this document. Secondly, whereas the DOTC inserts itself into the mainstream of the USG's ordnance development process, the NSAC has always been envisioned as an adjunct to the Federal Acquisition Regulation based mainstream program, providing external perturbations to this core effort. In that respect, the NSATC created and oversees an industry/academe-only BDC responsible for augmenting current budgets, especially along the lines of the discretionary technology sandbox funding options previously cited in this document.

The initial years of NSAC operation (FY05/06) concentrated on establishing protocols, committees, and responses to congressional-directed programs in the areas of wet lubrication-free small arms systems, recoil reduction technologies, and lightweight ammunition projects. The subsequent maturation of the JCIDS requirements process during the FY07 and FY08 timeframe, provided membership with a broad-based view of avenues, wherein, innovative technology application could best be effected. Lessons learned during this stage permitted the NSAC to formulate a business calendar synchronized with the overall Department of Defense (DoD) goals and related realities of the Federal, Executive Branch, and DoD budget processes. The current business process is depicted in the accompanying figure. The key aspect the reader should glean from this admittedly busy roadmap is that the various concept/proposal solicitations generated by the NSAC are time-phased principally to the realities of the Federal Budget Process and the associated DoD/Department of the Army programmatic and fiscal processes.





The subsequent re-examination of the OTA model by the OSD, in the summer of 2007, forced a further recalibration of the acquisition process and at the time of this writing still had the potential to significantly impact the current Consortium Member Agreement (CMA) protocols and government member business relationships.

The re-establishment of a predictable business cycle has only recently been realized by the FY09 decision to relocate, on an interim basis, the NSAC acquisition responsibility to the National Business Center in Arizona (Department of Interior function) for the FY10 through FY12 budget cycles. This report does not address that forthcoming interim period.

The consortium began operations in 2003 with 27 charter members. During the initial period, the Government provided significant momentum to the undertaking in the forms of solicitation releases, website establishment, and meeting planning. After this inaugural period, the NSATC began to exert oversight and management as the governance mechanisms took hold and as the Business Development Committee operations emerged. Website control was transferred from the USG to the Executive Director of the NSATC in January 2007. In a similar fashion, meeting planning, structure and logistics were subsumed by the NSATC partner even earlier. The net result is that the current (2010) partnership has become more robust and interactive as it heads into the second 5-yr period of operation. These developments augur well for the realization of the overarching intent of the NSAC - to provide a mechanism to spur radical innovation within the national small arms field as a natural complement to the requirements driven regimen stipulated by the DoD life cycle model.



## THE BROAD VIEW

The value and effectiveness of this consortium needs to be assessed from a rather unique perspective which fortunately, also maps directly with the congressional intent of the governing OTA enabling legislation. The National Small Arms Program, as defined by the JSSAP tech-base program, the relevant Product Management Office development and production support thrusts and the complementary logistics and demilitarization activities, is a coordinated and disciplined process underwritten by a highly prescriptive user requirement process. While the NSAC can serve as a valuable leveraging arm to support that process by such measures as short term prototyping efforts, it cannot mirror the more routine aspects of that larger established process without risking becoming an unnecessary redundancy to it. It can be a highly valuable and impactful resource when it occupies a different niche that complements and does not compete with that mainstream process.

From its inception, the NSAC was intended to serve as a supplier-push alternative to the requirements driven program. Its main focus should be to challenge the assumed status quo planning thrust by introducing paradigm-changing innovative technology opportunities for consideration and exploration by the war fighter representative entities. It is incumbent on the customer (the USG) to provide the supplier base with sufficient situational awareness of its extant and desired war fighter capabilities so as to fully inform them of the global as well as tactical status quo. As an adjunct to that communication process, avenues to reciprocally respond to that situational awareness must be fashioned and exercised on a predictable business calendar basis to provide a full closed loop business model. The first 5 yrs of NSAC operations were focused on creating the underlying business processes to establish the education and feedback loops of this grand scheme through the vehicle of identification and exploitation of innovation proposals. By now the reader will also appreciate the adverse impacts that resulted from external influences that either blocked or arrested the development of those underlying processes. As the NSAC moves into its second 5-yr period, there is guarded optimism that those barriers have been scaled or at the very least, somewhat mitigated subject to the list of unresolved issues cited at the end of this report section.

### Achievements

#### Lightweight Ammunition

Technology has provided the American soldier with incredible sensing and engagement capabilities especially as advances in solid-state and information technology exploded during the latter part of the 20<sup>th</sup> century. Ironically, such extensions in capability come at the expense of added weight, bulk, and cost. The NSAC muddy boots forums highlighted the organic infantry perspective that such tradeoffs were simply recognized as part and parcel of being a ground based warrior. Still, the ability to offset those added burdens without comprising a soldier's mission capability, surfaces as a major development opportunity. Ammunition as an expendable combat commodity, offers one such avenue to effect weight savings (or added firepower capability) through weight reduction efforts.

During its first 5-yr period of operation, the NSAC provided two discrete benchmarks in the realization of that goal. The PM-Maneuver Ammunition Systems office sought to establish the state of the art benchmark for polymer based ammunition prior to making substantial investment in legacy system ammunition manufacturing facilities. Legacy systems, such as the cal. .50 heavy machinegun or the 5.56-mm M4 carbine, employ feed and extraction systems that require an aft-ended grooved and rimmed brass casing in order to extract spent rounds from the chamber. The stresses inherent in such a design require work hardened metallic materials to survive the peak chamber pressures and the relatively high extraction

forces for such automatic weapons. Conversely, in areas away from this portion of the casing, ductility is required in order for case sealing by the casing body as well as predictable bullet insertion and extraction forces for consistent interior ballistics of such rounds of ammunition. Cartridge case brass readily exhibits all of the properties when properly work hardened, tempered, and annealed during manufacture. Exhaustive prototyping efforts among three individual members during FY05 through FY08, concluded that while the newest polymers offered significant improvement over 20<sup>th</sup> century engineering resins, a militarily viable design - functioning over the full spectrum of environmental conditions - was not yet feasible. The multi-component nature of those designs exhibited functionality at mid-range environmental conditions, but suffered from cold temperature material failure issues within the resins themselves and by component sealing and separation phenomena in both ambient and cold temperature extremes.

The second avenue of approach to developing lighter weight ammunition designs serves as the innovation model originally envisioned in enacting the OTA supporting legislation. A one person firm, Fleximation Corp, proposed the use of stainless steel as a substitute for brass casings. This concept offered a potentially simpler and more environmentally neutral stamping manufacturing process with concomitant lighter weight (20% of total cartridge weight). If successful, it also opened up domestic ammunition manufacture to a potentially new supplier base, the metal stamping industry. Acting as the prime contractor, Fleximation teamed with the then traditional firm, SNC Corp to conduct both paper and prototype manufacturing programs resulting in successful hardware demonstrations in both blank and service grade ammunition in calibers 7.62 and 5.56 mm. At present, the process is being re-examined to be more conducive to traditional metal stamping procedures and less exotic steel formulations. This approach departs from the baseline traditional draw and machining process associated with brass casings to take even fuller advantage of the more simplistic stamping process concept. The projected 20% overall weight savings offer the potential to lighten combat load or increase the soldier's firepower capacity. As a minimum, even if deployment of this concept is limited to the less demanding (interior ballistics requirements) blank ammunition role, such a strategy would free up vital service grade ammunition manufacturing capacity in existing load plants.

### **Alternate Tracer Technology**

Small caliber tracer ammunition principally serves three functions. It provides a visual cue to the gunner to their general line of fire. It is also employed by squad leaders to designate an area for squad engagement. Lastly, it is often bunched in multiple rounds at the end of a magazine or belt to alert the gunner that his ammunition supply is about to be emptied. The item is intended to provide a reasonable trajectory match to its service grade round counterpart; however, due to the requirements to provide sufficient volume to house pyrotechnic matter to produce the visible trace effect, such matches are not identical fits throughout a trajectory. The mass production manufacture of this item presents significant challenges on the production floor in terms of maintaining product function and repeatability given the inherent variance in environmental and product constituent factors.

Spurred by in-house internally funded efforts of the University of Louisiana at Lafayette, Louisiana, a new concept was developed in which phosphor luminescence technology permits service grade ball ammunition to be directly adapted to tracer functions by a mere augmentation of its base with this luminescent material. While early in its development stages, this concept offers the potential to reduce gunner disclosure as well as to simplify manufacturing processes, logistics, and costs significantly. The war fighter community has already identified this concept as of high interest based on prototype demonstration dubbing it as "tracker" ammunition so as to differentiate it from the current fielded tracer capability.



## USMC Infantry Automatic Rifle (IAR)

The USMC previously identified a need to field this system as a partial replacement for current fielded small arms individual weapon systems. Their initial acquisition strategy featured a set of aggressive requirements for thermal management, reliability, and other functional features in an attempt to radically push the state of the art envelope in weapon design. Their two-stage strategy initially required potential bidders to construct and deliver operating prototypes for service evaluation as a precondition for entering the subsequent phase two maturation and fielding competition. In theory, evaluation of this phase one prototype hardware would permit the USMC to gauge the realism of their stretch requirements prior to committing to a full scale development and fielding program. The NSAC is principally focused on providing proof of principle prototypes and as such enabled the USMC to execute this initial phase one strategy with delivery of three separate design concepts. Their subsequent evaluation and analysis allowed the USMC to refashion those requirements in a subsequent downstream program.

### Tech Base Achievements

The JSSAP Advanced Technology Objective (ATO) thrusts have produced the following significant results.

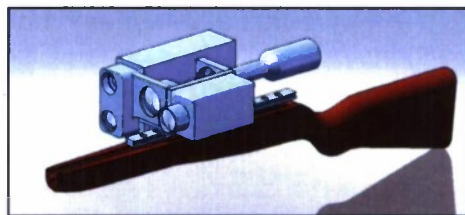
#### Advanced Fire Control

Two new contracted efforts were awarded focused on the following subject areas:

- Covert radio frequency (RF) sensor for location and tracking of defiladed human targets for enhanced lethality
- Automated target tracking laser range finder for small arms target acquisition/fire control



RF sensor on a weapon



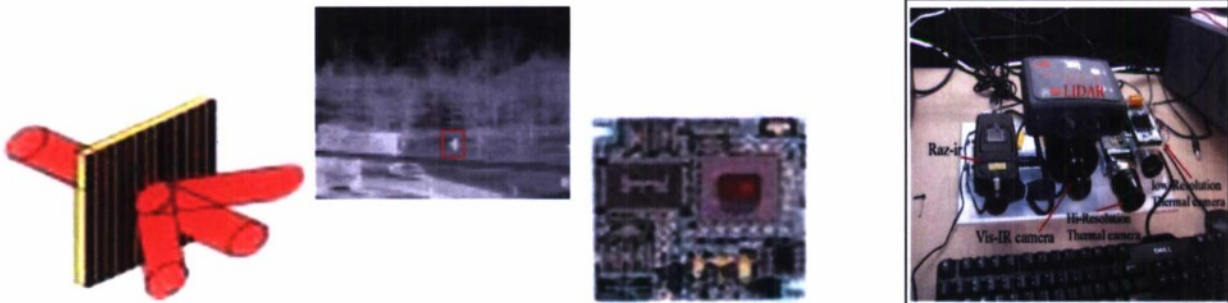
Thermal camera target tracking

During FY08-09, the Advanced Fire Control ATO supported multiple technology design approaches to address ATO metrics and goals. A Technology Readiness Level (TRL) 2/3 was achieved on multiple designs that are incorporating technologies into the following areas:

- Multi-wavelength imaging target acquisition system comprised of a dual laser radar system
- Acoustic SONAR and forward looking infrared image acquisition technologies



- Transmit/receive optics for digital vision optics
- Integrated technologies for laser range finder
- Software target and tracking algorithms
- Laser beam steering
- Laser signal processing
- These designs will continue to mature throughout FY10



### Advanced Lethal Armament Technology (ALA)

This ATO effort is a 3-yr 6.2 effort that was designed to find, mature, and demonstrate state-of-the-art component technology that when integrated, tested, and fielded has the potential to bring new and improved capabilities to the unit and to the individual war fighter. The focus for the ALA ATO was guided by select capability opportunities that were identified in the CBA and the joint small arms capability assessment. These areas came directly from the war fighter community and underwent several assessments prior to the ALA effort. As a result of this process, it was determined that advancements in certain critical component technologies were possible to meet or exceed future Army objectives. The ALA effort targets several of these areas including: guided munitions, recoil mitigation, controlled fragmentation, scalable effects, precision effects, component miniaturization, warhead efficiency, and other aspects of getting more effects on difficult targets.

### NSAC FY08 through FY10 Accomplishments

For FY2009, the advanced lethal armament technology for small arms ATO supported multiple component technology to meet ATO metrics, TRL goals and other program goals. The ATO metric areas are small fragmenting munitions, controlled directionality of fragments, and recoil reduction. The accomplishments for each area are as follows.

### Small Fragmenting Munitions Component Technologies

**Dynamically Reshaped Warhead (August to December 2009) - Phase I.** This effort is a conceptual 40-mm warhead that reshapes the fragmenting body prior to detonation dramatically improving the distribution of the fragments on target. Benefits of this conceptual warhead include improved fragmentation and fill in gaps left by conventional fragmenting warheads. Effectiveness modeling has shown an increase in effective area compared to a non-expanding warhead.

**Directed Fragmenting Munitions (August 2009 to July 2010) - Phase I.** This effort is a conceptual 40-mm munition that focuses all or most of its fragments in a preferred direction to effectively engage targets in defilade and increase lethality. The benefits for this conceptual munition are: improve effectiveness on target by controlling directionality of fragments and enhanced fragmentation design.

#### **Control of Directionality of Fragments Component Technologies**

**Optically Fuzed Air-Burst (OFAB) Munitions (July 2009 to June 2010).** The 40-mm OFAB munitions effort combines optical fuzing with the M433 round to increase effectiveness on targets in defilade. Benefits of this conceptual 40-mm round are improved performance on target compared to a point detonating round by means of controlling fragment directionality through airburst; it provides on-board proximity sensing permitting range determination; and increases potential for 40-mm fragments to hit targets hidden behind cover such as low walls, rubble or entrenchments without overhead cover.

**Laser Guided Projectile (January to May 2009) - Phase I.** The purpose of this effort was to mature course correction component technologies to reduce delivery errors and place more effects on targets in defilade. The objectives were to define key parameters for tracking and controlling a projectile in flight to improve terminal effects and determine a satisfactory configuration of a tracking and communication method for the projectile. Trade studies were completed to determine roll attitude, methods for data communication, methods for redirecting trajectory, and providing power to the projectile.

**40-mm Precision Munitions (July 2009 to March 2010) - Phase I.** The 40-mm precision munitions effort addressed enabling technologies for enhanced lethality against targets in defilade including range estimation, muzzle velocity variation compensation, and aiming/guidance. An analysis of alternatives tool was developed to evaluate probability of incapacitation and the effect of the error budgets on P(I).

#### **Recoil Reduction Component Technologies**

**Advanced Recoil Attenuation Effort (July 2009 to August 2010).** The advanced recoil attenuation effort assessed and quantified the contributing factors and aspects of recoil in small arms systems. This effort includes human factor considerations and is based on a range of small arm systems. The timeline and cause for the recoil of different types of weapon operation cycles were successfully completed. Various recoil impulse ranges and how and when that impulse is applied to the shooter were also investigated.

#### **White Paper Processes/Impact on Communication within the Domestic and International Small Arms Industrial Base**

If innovative prototyping is the engine of the NSAC/NSATC construct, then information flow is its fuel and lubricant. In its relatively brief history, the NSAC has enhanced established small arms information channels or in fact introduced new conduits to further state of the art advancement. The NSAC website is viewed as a monthly magazine which is deliberately refreshed at that frequency. The Research Program Director authors a monthly column titled "Thinking Out Loud" to provide a conversational tone update to emerging events and opportunities. The JSSAP Jottings is published multiple times throughout the year describing



technical events, trends, and initiative and it too is featured in the web content page. The members-only section provides archival information on briefings, articles, etc. serving as a valued reference source. All solicitation products such as RPPs, RBDPs, and white paper results find their way to this information depository providing real time access by members.

The members meetings, held on a semi-annual basis, provide numerous forums by which members can develop improved situational awareness about the product lines, fellow member capabilities, and user needs via formal briefings and sidebar discussions. The meeting agenda also features speakers providing not only technical, but capability, legal, acquisition/procurement, national laboratories work/capabilities, and other "need-to-know" background data to make membership more competitive and responsive to USG needs. In a complementary thrust, the NSAC briefs each year at the annual Small Arms Symposium sponsored by the National Defense Industrial Association. A companion meeting booth is established in that forum's exhibit area each year to recruit new members and to serve as a meeting locale to forge partnerships, etc.

### **Closer User Linkages**

Throughout its 5-yr existence, a prime goal of the NSAC has been to forge an even tighter link between the war fighter and its international supplier base. It only makes sense that a supplier push organization needs to comprehend its customer base's goals, constraints, and timelines. In this regard, Ft. Benning's Small Arms Division is a pivotal element in fostering closer collaboration. In that regard, "the Home of the Infantry" has willingly agreed to serve as a site for one of the two semi-annual NSAC members meetings each year. They provide contemporary updates on the national strategy, but just as importantly, organize what is now called Muddy Boots forums during these events. Simply put, Muddy Boots consists of real time panel discussions featuring recently returned troops from theatre operations in Southwest Asia as representation from all rank echelons. Troops discuss operational experiences, strengths, shortcomings, etc. of the various small arms systems deployed in these environments providing members with highly sought after experiential feedback. These same panel members are then made available for private one-on-one sessions with members in which more detailed discussions can take place. An outgrowth of this interchange has been The Small Arm's Division's willingness to share troop feedback questionnaire results with credentialed industry original equipment manufacturer (OEM) PM's for their respective systems on an annual basis. Over the longer haul, such collaboration is deemed a critical catalytic agency for truly spurring high technology innovation in small arms.

### **Deliberate Mechanisms for Co-operative Industry-Academe-Government Interchange**

Information is the currency of innovation and therefore establishing effective communication exchange mechanisms is a foundational tenet of that process. The CMA provided the framework for the nascent efforts to achieve that steady state condition. The CMA requires an Executive Committee (EC) to oversee the governance activities of the Consortium aided by the Executive Director competitively selected through a solicitation process. The EC make-up originally consisted of the charter members of the previously referenced CSAP on the industry/academe side and a selected number of comparable USG officials on the governmental team. The original plan called for periodic elections on the non-government positions, but the challenges faced during start-up to be detailed in these pages warranted a more deliberate pace in this requirement to preserve continuity as the consortium sought to establish its operational roots. The Executive Director serves as the principal administrative officer for the Consortium handling governance, fiscal, communications, and business development responsibilities.



An echelon below this group is the Research Program Committee (RPC). To date, this group has principally served to evaluate white papers (through its subcommittee system) and to act as an ad hoc brainstorming source for special events and during membership meetings. The panel is composed of equal number of USG and industry members as stipulated by the CMA. The CMA also calls for the preparation of an annual plan to be reviewed and approved by the EC each year. Responsibility for this event rests with the Research Program Director (RPD). During this first 5-yr period, that activity chiefly consisted of an ad hoc regime of opportunities developed by the RPD in the years FY05 through FY07. That "on-the-fly" approach was subsequently supplanted by reliance on addressing the approved ATO thrusts of the Joint Service Small Arms Master Plan.

The members of the RPC in turn co-chair one of four subcommittees who do the ground work evaluation on the white paper assessments. One each USG and industry RPC member oversee the small arms weapons system, grenade machinegun system, materials and processes, and advanced technology subcommittees. By design, those committees are disproportionately staffed by non-USG employee members to assure a truly supplier-push mentality takes hold at the "grassroots" level of the NSAC. There is much debate about the level of initiative and authority that the committee constructs should assume and exercise. Obviously, appropriated monies can only be disbursed via officially recognized governmental channels. A more activist model of these groups would also require additional demands of time from those volunteers to promote and sustain continuity of operations. To date both of these factors have tended to restrain the sphere of activity of this aspect of the consortium.

The industry-academe portion of the partnership does operate one non-governmental operation; viz., the BDC. This group is charged with promoting the operations of the consortium while favorably influencing the reputation and fiscal health of the national small arms initiatives. To this end, the BDC receives the final white paper assessment each year from the RPC after having already received both USG and EC review and endorsement. That product serves to establish and underscore the viability and opportunity potential that members potentially can bring to modernization and upgrading United States small arms capabilities.

## UNRESOLVED ISSUES

The foregoing pages have documented the launch, maturation, and difficulties of the NSAC/NSATC's first 5 yrs. While admittedly written in capsule summary format, the reader should now be sensitized to a series of issues that require careful investigation, analysis, and potentially decisive resolution. This section briefly lists the key challenges while providing sufficient context to evaluate the conclusions and recommendations listed in the final section of this report.

### One-size-fits-all Regulations do not Admit to Special Circumstances

A running joke in our community is that small caliber not only depicts the munitions' size, but the magnitude of its associated budget. Put another way, even with the relatively large density production that small caliber presents, total development and acquisition costs are inevitably on the "wrong" side of the decimal point when Defense budgets are discussed. The OTA provides significant relief from FAR based acquisition regulations, but counterbalances that relief with provisions designed to assure new business entrant firm participation in a robust manner. Congressional sensitivity to this issue was certainly illustrated from congressional reaction to the Army's Future Combat System (FCS) program's attempted use of the OTA to manage its system of system programs. At that scale of expenditure and import, the congressional strictures were certainly appropriate and well focused. The small arms

marketplace on the other hand, is highly competitive on a global scale but with major player's capitalization profiles significantly below larger DoD suppliers of major systems such as the FCS program. To meaningfully innovate within the small arms sector, OEM participation is vital and in fact may be both a necessary and sufficient condition to meaningfully apply emerging technologies to legacy weapon system segments of the battlefield environment. The NSAC/NSATC attempt to sensitize departmental leadership of this scaling issue met with empathy, but failed to evoke the waiver latitude afforded within the legislation itself.

### **Single-Point Entity or Dejure OTA Execution Compliance**

The present departmental interpretation of the governing OTA statutes requires that these key OEM suppliers must either partner with non-traditional firms or cost share to the tune of one-third of total contract costs. Currently, the NSAC/NSATC structure operates on this set of rules; however, over the longer haul this uneven playing field is bound to discourage active participation in all but obvious win-win situations. The OEM's have the resources and experience to more broadly influence and impact this weapon genre with innovative ideas and inventions, but to be relevant, they must be actively involved on a sustained and continuous basis. The only known approved alternative to this dejure approach is the single-point entity concept previously described in the FY07 and FY08 section of this document. The creation of this entity certainly provides an opportunity to level the playing field for all members of the consortium. That benefit comes at the expense of likely added administrative expense (keeping in mind the earlier observation that the small arms budget has relatively limited resources already) plus the relegation, again dejure, of the members to subcontractor status. In a highly individualistic business such as small arms, this requirement serves to represent a poison pill, especially to many of the smaller and innovative firms the legislation seeks to engage in an increased participatory role. Clearly, the scaling factor needs to be considered in such cases.

### **International Traffic in Arms Regulations and Structure**

From its inception, the NSAC has been modeled after other prior consortia in which membership was constrained to United States firms. Defacto, the U.S. military small arms profile features significant foreign participation albeit in some instances under independent United States subsidiary relationships. The International Traffic in Arms Regulations (ITARs) conformance in this venue requires very careful "plain vanilla" information sharing to assure strictest compliance. Early level soundings of the likelihood that exemptions could be granted for the NSAC/NSATC effort were met with strong and resounding denials. Recalling the metaphor mentioned earlier of communication and information sharing as the fuel/lubrication of the innovation engine that the NSAC aspires to be, the current structure and ITARs framework serve as a heavy speed governor on the innovation "engine" process, significantly limiting its future potential.

### **Less Structured Tech Base Opportunities - The Sandbox Concept**

Clayton M. Christensen, in his hallmark book, "The Innovator's Dilemma," proposed answers to a fundamental question of the 1980s and 1990s - viz., why did so much innovation in the information technology arena come from small start-up firms? Christensen concluded after years of research that existing firms were invested in and were highly protective of the status quo. In a separate book, Lou Gerstner, former IBM Chairman and CEO, recounted the sacrosanct attachment managers of that firm held for their mainframe computer line of products when he first assumed leadership of that major firm. He concluded that this myopia had blinded



the firm to the changing realities of the information management business (what Andrew Grove, co-founder of Intel has termed “strategic inflection points”) resulting in frittering away golden business opportunities such as the aggressive development and marketing of personal computer and related DOS operating systems. Those innovations were viewed as threats to the mainframe business itself! Wedded to the status quo, IBM experienced significant business reversals, which Gerstner’s tenure set about reversing through a new business model.

Small arms have endured a highly evolutionary and relatively slow paced innovated heritage. The innovation sparking the OTA instrument is designed to draw in new blood in non-traditional technologies. To properly leverage that potential participation and creativity, adequate free-form discretionary resources need to be carved out of an existing and admittedly constrained budget. Presently, that budget must be husbanded against specific approved programs, by and large. There is no predictable pump priming process/resource pool to grow that non-traditional commodity perspective. The status quo in small arms is a form of mainframe worship. Christensen, as one of his curative prescriptions, advocated that large firms establish and shelter independent internal units whose charter was the destruction of the corporation’s current mainline product/service line - because in actuality, their more agile less hide-bound competitors were already executing an external business model precisely focused on that same outcome! I term the creation of this free-form discretionary funding pool as the sandbox model for the purposes of this discussion.

### **The Maturation of the Business Development Committee**

This entity is an industry only activity designed to advance an agenda that small arms requires more resources to flourish, has a wealth of unmet and high potential opportunities to exploit and is highly relevant in our current national strategy as the United States faces persistent close combat asymmetric warfare scenarios. The industry segment of the EC holds the authority and resource control to mature this group especially as revenues increase through membership growth (five fold over a 5-yr period) and as contract award levels increase (NSATC receives 1% of all contracting dollars remitted directly by successful members to the NSATC).

### **Structure and Governance in the Future**

In its formative period, great reliance has been placed on continuity of operations, participation, and governance using the Committee of Small Arms Producers as the touchstone. That strategy served the Center well while it attempted to ground itself in terms of membership development, business process establishment, and CMA benchmarking. Given the host of issues described within this section or detailed in earlier parts of this report, a fresh look at the CMA, the resource model, and the industry-government-academe model is both timely and in fact mandated. The template used to construct this consortium put us in the right “church.” New efforts should be exerted to place it in the right organizational and operational “pew.” The final section of this report summarizes alternatives to address all of the issues outlined in this section.

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## Research Program Committee

As noted in an earlier portion of this report, the role of the RPC and its subcommittees is described within the CMA, principally in the context of an annual plan. This concept was borrowed from the DOTC, which has served as a forerunner to the NSAC. The difficulty resides in the differences between those two consortia, wherein the NSAC does not seek to serve as the main conduit for development activities, but rather as a strong supplier-push adjunct to an OSD authorized Joint Service Program process dating back to 1978. Efforts to invigorate the span of control and authority of the RPC structure must reconcile that difference coupled to the associated cost of staffing a more energetic industry-government committee structure. Such an expanded role would demand frequent involvement by committee members since continuity of operations is a prerequisite to assuring such a concept would be, in fact, both viable and effective.

## THE FUTURE

### Resolving the Issues

This discussion addresses the critical issues raised in the preceding section on a “most to least” priority basis. Before entering that final phase of this report, it is important to emphasize some key findings from this first 5-yr period. When viewed against these conclusions, the sense of priority and urgency of prosecuting the resolution of those issues becomes both apparent and compelling:

- If the first 5-yr period of operation demonstrates nothing else, there is a rich cache of potentially paradigm-shifting technologies available for exploitation and application to small arms.
- The NSAC/NSATC has practiced and demonstrated the efficacy of the underlying premise of the OTA authorizing legislation; viz., that non-traditional entities can and do bring such technologies to the fore.
- Timely and efficient procurement processes are imperative to attract and maintain the initiative, which this novel acquisition strategy engenders.
- The JCIDs based CBA provides an excellent framework from which to pursue a supplier-push innovation initiative.

### The Sandbox Imperative

Not surprisingly, funding serves as a governor in accelerating the pace of innovation within the national small arms arena. As stated earlier, small arms have not commanded a disproportionate segment of the Defense budget at any period beyond World War II. The cold war stretched for almost 50 yrs and the nature of the threat drove the emphasis toward strategic weapon system development and continued innovation. By the mid-1990s, analysts increasingly predicted the proliferation of terrorism as a national threat. Those predictions were sadly realized on 11 September 2001. Some of those same analysts also cautioned that once this threat arose, it would plague this nation for multiple decades just as its cold war predecessor did. This country’s response has necessarily featured an array of both high technology and close combat warfare strategies with the latter being the center of mass over the long haul.

While the CBA provides an excellent starting point, there must necessarily be a companion pool of discretionary funds (preferably fenced off at a modest \$2 to \$5 M level) to investigate proof-of-principle high risk/high reward concepts aimed at establishing feasibility determinations up to Technical Readiness Level IV (TRL IV is defined as “Basic technological components are integrated to establish that they will work together. This is relatively ‘low fidelity’ compared to the eventual system. Examples include integration of ‘ad hoc’ hardware in the laboratory”). Those funds could be carved out of existing resources or better yet, appropriated under a new increment to the extant tech base budget. Such a strategy is in tune with successful innovation strategies pursued by leading firms such as 3M among others. The ad hoc nature of the current process, underlying the first 5-yr NSAC operations, relies heavily on elements of serendipity to create those paradigm-shifting results. Contrary to some common perceptions, technology breakthroughs are not occasioned by such chance events but more often are the product of a well planned risk-accepting business model. In that same vein, the existence of such a protected pool of resources would likely stimulate more technology-adept firms to invest and participate in this arena over the longer term.

#### **Other Transaction Agreement Regulatory Relief – Size Matters**

As stated in the prior section, the NSAC continues to adhere to the most traditional interpretation of the OTA regulations, imposing cost-sharing and/or non-traditional partnering as a criterion of participation for its traditional firms, most of whom can be viewed as vital OEM manufacturers. In this highly competitive small arms commodity market, OEM participation is vital since the turnover period for systems in this genre ordinarily far exceed other major systems life cycles. Small arms systems remain fielded for not only multiple decades, but a century in the case of the venerable caliber .50 M2 Browning machinegun! The current structure has the potential to create disincentives for those traditional firms to produce radical independent innovations and to sustain interest in the NSAC itself. The current regulations admit to waiver provisions at the departmental level and as noted earlier, in 2008, the NSAC attempted to exercise such an initiative. This alternative should again be revisited with the new wrinkle that specific self-policing metrics regarding non-traditional participation be specified and rigorously exercised to fully comport with the obvious underlying legislative intent. Past performance clearly evidences the NSAC’s ability to perform to such ambitious measures.

#### **International Traffic in Arms Regulations Alternatives**

There is realistically little probability of altering the ITARs environment in today’s global climate. The NSAC/NSATC needs to adapt to that reality. Current information processes are highly disciplined by the mandate to conform to ITARs. While not a crippling constraint, it does place a relatively modest ceiling on the NSAC innovation potential. The NSATC governance authorities should seriously consider a bi-modal method of operation in which United States national firms, exempt from ITARS information exchange restrictions, can be independently addressed by the USG on a subset basis with less fettered information sharing constraints. While the mechanics and ramifications of such a structure would need to be fully assessed, the feasibility and desirability of morphing to such a structure should be vetted in the short term by the NSATC executives along with a final resolution on the alternative single point entity model for long-term operations.



## **Maturation of the Business Development Committee**

This portion of the partnership is wholly owned and directed by the non-USG segment of the partnership. It is sufficient here to point out that the USG partner continually seeks to inform its chain of command of the viability and impact of the NSAC/NSATC initiatives and that its partner should likewise seek to expand membership and visibility within its own business channels as a priority to complement the USG thrust as intended in the CMA.

## **Research Program Committee Operations**

The potential restructuring/expansion of the RPC should only be attempted after a thorough vetting by the entire Industry-Academe-Government Executive Committee, preferably after elections are held for that body in the near future. That vetting process would serve to more tightly collimate the intents and goals of this consortium, armed with something the original EC membership never possessed, the benefit of 5-yrs worth of operation and DoD oversight.

**APPENDIX**  
**CAPSULE SUMMARIES OF FIVE-YEAR PROGRAM ACTIVITIES**



## FY05 Program

The FY05 program centered on a congressional plus-up specifically targeting three emergent technology needs/trends. Those three thrusts were as follows:

1. **Lightweight Ammunition:** The infantry squad continues to absorb more capability owing to technology advances. That enhanced functionality brings with it added weight potentially jeopardizing mission capability and soldier survivability in a worst case scenario. Ammunition represents a weighty fungible commodity whose redesign could prove highly beneficial in reducing or at least offsetting the load gains incurred with those new technology enhancements. The FY05 program specifically targeted one major question - is there state of the art advances in materials science that could provide the functionality of extant brass casings at reduced weight/manufacturing costs?
2. **Recoil attenuation/ancillary energy recovery:** Weapon recoil is a major contributor to small arms weapon system delivery errors (accuracy). The magnitude of weapon recoil can induce involuntary flinching on the part of the shooter as well as physically displacing the weapon aim point from the line of sight of the intended target simply by the forces produced on the gun during the firing cycle. Soldier training addresses those issues experientially; however, technology mitigation could augment that approach or partially supplant it under the best of scenarios. Somewhat allied to that objective was the recognition that much of the mechanical energy generated during the weapon firing process goes for naught other than propelling the projectile (bullet) down range. Some of enhanced technology devices provided to the soldier require energy sources which in the past have resulted in a proliferation of batteries to power those devices. The war fighter has voiced increasing concern over this alarming logistic trend. The FY05 program explored the possibility of recovering some of this propulsion-induced energy from the weapon cycling processes.
3. **Lube-less Weapon Systems:** Like many mechanical systems, small arms weapons require lubrication subsystems to operate efficiently to overcome the effects of surface-to surface friction as well as to minimize wear of those contiguous surfaces. Furthermore, small arms systems must operate in a full spectrum of environmental conditions to include extreme hot and cold and relatively dirty ambient surroundings. Due to deployment within maritime environments, guns must also be fitted with rust-prevention mechanisms to insure continuous availability. Wet lubricants have historically serviced these multifaceted requirements supplemented by vigorous weapon cleaning regimens. Operation Desert Storm and the tragedy of 9/11 resulted in high tempo US operations in Southwest Asia whose "sandy" (actually talc powder-like) environment significantly challenged those standard operating procedures. The ability to replace so called dirt attracting wet-lubrication systems with dry coating surfaces became a central thrust of this activity.

The FY05 program ultimately provided the following results in each of these technology initiatives:

1. Polymer (plastic) material substitution for conventional brass material in cartridge cases demonstrated significant state of the art improvement over prior art during this period. To realize this potential, these cases designs had to necessarily become multi-component in construction to mimic the widely diverse properties that work-hardened and annealed brass can exhibit (and in fact is critical to cartridge function) in normal manufacture and operation. The potential to save upwards of 20% in weight on a cartridge to cartridge comparison was not realizable due to the following state-of-the-art limitations:
  - a. The multi-component nature of the cartridge required effective sealing between components to assure full functionality. This capability was not realized during this program
  - b. While some designs performed admirably at ambient and hot temperature environments, cold temperature performance (below 0 degree Fahrenheit) was generally unacceptable due to component separations and/or material failures.
  - c. Plastic materials generally required larger case cross-sectional thicknesses to provide equivalent mechanical integrity which reduced available case volume. That reduction in volume reduced available propellant capacity resulting in an inability to provide the requisite exterior and interior ballistic profiles required for terminal effectiveness and reliable system operation.
2. A second lightweight case concept emerged that featured the application of lower density stainless steel material to replace conventional brass offering an attendant potential 20% weight reduction in ammunition. This concept also offered the benefits of simplified and more environmental friendly manufacturing processes as well as less complex component construction designs. At the conclusion of the FY05 program, this effort held sufficient promise to authorize further development and proliferation to other calibers besides the baseline 7.62mm initiative.
3. Efforts to reduce recoil specifically centered on addressing this issue in the increasingly popular caliber .50 sniper rifle family of weapons (M107/XM500). The net result of those programs was delivery of prototype systems that resulted in user and technologists evaluations yielding valuable data acquisition and lessons-learned.
4. Efforts to recover mechanical energy and transfer it into usable stored electrical energy affirmed the ability to marginally convert and harvest such resources but failed to generate storage mechanisms whose size/weight profiles would be ergonomically acceptable to the war fighter.



5. A multi-vendor approach to non-wet lubrication weapon system investigations had one common element - the deposition of lower friction hard coatings to the ferrous operating components of selected small arms weapon designs. Those approaches were typically investigated by non-small arms designers and/or producers whose lack of familiarity with this product line soon handicapped the program. These efforts were undertaken at a time when the US weapon production base was severely taxed by the high tempo operations of the military which impeded both the ability of extant manufacturers to partner with these nascent high tech coating firms and equally important, limited access to production items and dimensional/process manufacturing adjustments. As such, the studies were limited to the deposition of coatings to then standardized components. That sub-optimal strategy masked any potential performance gains by creating tolerance and interference conditions among these coated components resulting in assembly problems and operating malfunctions. The lesson-learned from this experience was the absolute imperative to have cooperative OEM partnering with active system producers from the outset on any such future endeavor.

The FY05 program served to establish initial program processes and to provide a forum for members to begin engagement with the Government on creating the supplier-push complement originally envisioned by the designers of this programmatic/institutional initiative. FY06 and beyond was to be the culmination of the carefully conceived and executed planning process begun in calendar year 2004 and 2005.

TOSA#	Member Firm	Total	Total Funds Obligated
0001	Barrett Firearms	Anti-Material Sniper Rifle	\$ 766,350.00
0002	Poly Ammunition Company	Case Weight Reduction	\$ 750,016.00
0003	Cape Aerospace LLC.	Multi- Functional Rechargeable Power Source	\$ 261,000.00
0004	Mississippi Poly Mer Technologies, Inc.	3,200 Rounds of Polymer Cased Ammo	\$ 250,000.00
0005	Fleximation Inc.	7.62MM Case Weight Reduction	\$ 71,488.00
0006	Frontier Performance Polymers Corp.	Lightweight Polymer Cases Small Arm Ammunition	\$ 87,154.00
0007	Materials & Electrochemical Research	Barrel Weight Reduction in the M107	\$ 138,911.00
0008	Mississippi Poly Mer Technologies, Inc.	Dev and Validate Lightweight Ammo	\$ 79,958.00
0009	FN Herstal SA	Recoil Mitigation	\$ 433,739.00
0010	Applied Thin Films, Inc.	Inorganic Oxide-Based Thin Films	\$ 235,000.00
0011	Integran Technologies, Inc.	Metal Coating for Guns	\$ 235,000.00

## FY06 Program

The FY06 program largely mirrored the FY05 efforts. The initial lightweight ammunition phase one paper studies ended and only limited discretionary JSSAP funding was available to address "supplier-push" initiatives. The explanation for the latter condition stemmed from the relatively long term developmental cycles associated with Defense Tech Base programs and the fact that the NSAC had been stood up just as JSSAP was involved in such a cycle mid-stream. In other words, a significant portion of program funding was committed to extant major on-going programs.

Fortunately, another emerging development partially compensated for this situation in the maturing of the JSSAP JCIDS analysis during this same fiscal year cycle. OSD created the JCIDS model to focus the requirements process on a capability-based assessment of war fighter needs via an exhaustive analysis of current operations down to the task level of activity. As originally conceived, it stressed seeking non-materiel development strategies wherever possible via use of other service in-hand equipment/hardware, changes in doctrine and tactics, revised training etc. This strategy emphasized seeking more responsive and less costly alternative measures before costly developmental initiatives were launched. A decision to approve and undertake a requirements-driven materiel development program was intended to be weighed against those other-alternatives in a thorough vetting process. The JSSAP-sponsored Small Arms JCIDS effort involved all of the services reflecting a true purple overarching view of needs. It would later be renamed the Capabilities-Based Assessment in 2007 as the Infantry Center sought to sharpen its focus.

The NSAC provided a broader overview of the interim JCIDS product to the NSATC membership, somewhat constrained by two significant factors; one factor was germane to the current operational situation and the other consideration was grounded in existing legislative prohibitions. The former factor centered on the nation's war footing in Southwest Asia which by operational security (OPSEC) considerations, precluded exposing shortcomings and/or deficiencies explicitly to the general public. As such, great pains were taken to present USG areas of interest in such a way as to totally mask that aspect of the JCIDS analysis. The second factor involved the prohibitions imbedded in the International Trafficking in Armaments Regulation (ITARs) which placed considerable limitations on export of technical information to non-US concerns. Since the NSATC was international in membership, this set of restrictions applied as well. Fortunately, the same approach used for OPSEC satisfied the ITARs constraints although both conditions significantly modulated the supplier-customer communications channels. That situation still prevails today as well.

Members, now armed with the permissible broad outlines of the JCIDS drill (through member meeting presentations the RBDP and White Paper solicitation processes) were encouraged to advance supplier-created mid and long term concept outlines for USG review and consideration via the RBDP and White paper avenues. The inaugural white paper collection was relatively large in number but on the whole, admittedly very short term in perspective. Subsequent years work have sought to extend the reach of these submissions through continuous USG-member dialogue via the member meeting format, pre-solicitation conferences and website based commentary and briefings.

Two major awards were made during this year, both involving investigation of lower weight and lower recoil weapon system design in caliber .50. TDI's program focused on the machinegun role while American Arms and Ordnance received a similar award for a caliber .50 sniper platform. Unfortunately, the founder and owner of AAO deceased shortly after contract initiation requiring the USG to bring that effort to a premature orderly closeout.



The NSAC supported the Marine Corps in the procurement of prototype weapons for an aggressive effort termed the Infantry Automatic Rifle (IAR) intended to replace some existing 5.56mm weapon systems within the Corps with new systems that would have state-of-the-art advancements in areas such as thermal management and reliability. To test the state of the art, potential long term suppliers were first required to submit phase one operating prototypes for independent USMC evaluation. Those prototypes were designed to permit the Corps to assess the realism of their stretch-requirement approach before spending serious money on an aggressive development and fielding program. The NSAC handled the prototype procurement phase of this project and delivered samples from two of the three selected firms.

FY07 as will be noted shortly, would mark the beginning of a steady-state method of operations culminating in FY08 when all three innovation processes (RPP, RBDP and White Papers) would be energized; when core funding would be made available from the JSSAP funding lines and lastly member awareness of User needs and shortfalls via the JCIDS analysis would come together to form a fully functional environment.

TOSA#	Member Firm	Total	Total Funds Obligated
0012	SNC Technologies Corp.	7.62MM Light Weight OT NSAC/NSAT	\$ 784,794.00
0013	FN Herstal SA	Review Program and Final Report	\$ 287,095.00
0014	General Dynamics Armament & Technical P	Delivery of Prototype and Demonstration Support	\$ 311,386.00
0015	Leitner-Wise	Delivery of Prototype	\$ 10,488.00
0016	Mississippi Polymer Technologies, Inc.	Developmental Effort Phase I and Delivery	\$ 295,472.00
0017	Frontier Performance Polymers Corp.	Development Effort Phase I	\$ 421,012.00
0018	Poly Tech Ammunition Company	Phase I Contractor Summary Report; Phase II Summary Report; Phase III Report and Date Package; 300 Unassembled Rounds; 106,000 M855 Ball Catridges	\$ 1,082,196.00
0019	Knights Armament Company	Heat Management Study; Final Tech Report	\$ 299,600.00
0020	Transformational Defense Industries, Inc	Advanced Recoil Reduction	\$ 616,335.00
0021	American Arms and Ordnance	Light Weight Weapon System	\$ 249,976.00

### FY07 Program

FY 07 marked a year of transition within the NSAC. During this year, core program funding from JSSAP would still be lacking as extant programs continued to command most of its fiscal resources. RBDP-II would be solicited again calling for members to exert a supplier-push focus to the extant USG small arms plan by responding to a JCIDS-driven menu of desired capabilities and improvements. Members were assured during the winter member's meeting that beginning in FY08, a dedicated core of Tech Base funds (\$4M in FY08) would be set aside for two Advanced Technology Objective (ATO) Program efforts, viz., Advanced Fire Control Technology and Enhanced Lethality. A large part of FY07 energies would center on educating the NSATC membership on the nuances of these forthcoming ATO thrusts replacing the annual RPP as the principal focus for the year. In addition, RBDP-II was released in the winter of FY07 to continue the trend of mining the industrial base for strategy altering technology opportunities.

Absent JSSAP monies, PM/Office sponsored efforts formed the core of the FY07 program. Even this process was threatened by an unforeseen and potentially catastrophic event during that summer of 2007. A sister consortium's efforts had received high level review within DoD with a resultant finding that the ARDEC interpretation of the Other Transaction Agreement regulations had been found to be flawed. Specifically, the exercise of the cost sharing or non-traditional partnering stipulations associated with awarding of Task Order Sub

Agreements to traditional firms was called into question by higher headquarters. The ARDEC-model viewed the consortium as a single legal entity, with which the USG had established an OTA based partnership under the governing law. All members of the consortium, independent of their status as traditional or non-traditional members, could receive TOSA awards as long as the consortium as a whole contained substantial non-traditional membership (judged to be over 30%) and participation via the level of award activity. Using this form of metric, the NSAC consistently exceed this standard. Despite this quantitative level of achievement, higher headquarters did not accept that interpretation. In their judgment, each TOSA award stood on its own merits and individual members (and not the Consortium entity) had to meet the non-traditional membership criteria established in the law. In essence, the cadre of traditional members in the NSATC were required to cost share (33 1/3%) or partner with a non-traditional firm (by doing less than \$500,000 business per annum with the USG under FAR-based actions within the prior twelve month period) to receive TOSA awards. The effect of this ruling was to bifurcate the NSATC membership into these two discrete classes and to educate the members themselves on the rationale and import of this sea-change interpretation. That process lasted throughout FY08 and perhaps beyond.

This determination occurred late in the fiscal year prompting a need to redefine both a short and long term strategy within the NSAC as will be detailed in the FY08 and FY09 sections of this document. The FY07 awards were successfully made in late Fall only after agreeing to formulate a new strategy/process for the remainder of the TOSA period of performance (FY09) that complied with the revised OSD guidance.

A review of the awards made will inform the reader that the NSAC was maturing into its optimum acquisition niche role as relatively low level fundamental technology investigations started to evidence themselves as programs such as luminescent tracer concepts, special application hybrid propellant formulations and unique casing design studies emerged from that year's solicitation. The supplier-push emphasis was beginning to take hold!

TOSA#	Member Firm	Total	Total Funds Obligated
0022	Osram Sylvania Products, Inc	Cobalt Alternative	\$ 858,537.00
0023	St Marks Powder, Inc	Hybrid Propellant for 5.56MM Subsonic	\$ 118,210.96
0024	General Dynamics Ordnance	Lightweight Blank Cartridge Cases	\$ 333,519.00
0025	University of Louisiana at Lafayette	Luminescent Tracers for .45 Caliber	\$ 25,000.00
0026	Colt Defense LLC	Modular Case Ammunition Study	\$ 90,738.00
0027	Knight's Armament Company	Advanced Thermal Management in Firearms	\$ 389,205.00
0028	General Dynamics Ordnance	5.56MM Caliber Lightweight Cases	\$ 412,773.00

### FY08 Program

The events of the latter part of FY07 clearly possessed the potential to derail the momentum established within the NSAC as an innovation enterprise. The indication that the ARDEC legal interpretation had been flawed as it pertained to the contractual status of non-traditional and traditional firms, occupied a significant amount of effort especially in the first half of that fiscal year. A two prong strategy emerged to manage this crisis and to regain at least a measure of programmatic momentum.



One strategic salient centered on fashioning a new acquisition strategy (hoped to be an interim approach) that would preserve the option to award Task Order Sub Agreements within an OTA framework while simultaneously affording traditional firm bidders a FAR based avenue (should they not wish to stipulate to the cost-share/non-traditional partnering requirements as interpreted by the DoD). That strategy consisted of publishing a Broad Agency Announcement in FY08 permitting both of those avenues of approach to co-exist against the same advertised ATO capability needs. This complex solicitation instrument suffered a series of formulation and review issues which delayed its release until the latter part of the fiscal year. To compensate for this slippage, a relatively short response time for providing actionable proposals ensued to avoid even more dire complications of funding obligation defaults. The solicitation centered on the JSSAP ATO focused efforts of Enhanced Lethality and Advanced Fire Control. Ultimately, nine awards ensued from this strategy although three were not booked until early FY09.

While this BAA approach took hold, the NSAC decided to make a case for exercising another option, permissible within the governing regulations underlying the OTA law. That approach centered on obtaining a Departmental waiver to the cost-share/partnering provisions of the law. Subsequent briefings at the DA level presented the following case.

*The NSAC is a relatively small budget operation. The cost share and/or partnering mandates place the traditional firms within the NSATC at a distinct competitive disadvantage which threatens their long term participation within the NSAC. Since most innovative potential exists within the legacy family of small arms systems, their withdrawal individually or en masse would in essence make the NSAC stillborn since OEM participation is critical in high density mass production products such as small arms. As a bolster to that argument, the NSAC cited its current demographic performance history including non-traditional membership (almost 40%) and awards (over 30%) as evidence that congressional intent was being fully realized. The final corollary to this argument featured the proposition that the waiver could be withdrawn by the DA at any time should performance not match expectations.*

While seemingly well received in Washington during the formal waiver request briefing, ultimately DA declined to provide this relief, opting instead to direct strict compliance to the OSD interpretation of the law.

Toward the end of the fiscal year, another option surfaced to restructure the NSAC to allow for a defacto competitive and level playing field for both traditional and non-traditional firms. Termed the Single Point Entity (SPE) model, this approach had the advantage of OSD endorsement as an acceptable alternative to the ARDEC original interpretation. Under this model, the NSATC would engage a single firm to represent the consortium as ***the exclusive government partner*** in the OTA. Since this entity would only exist to contract under OTA instruments in the future, it could not by definition ever be classified as a traditional contractor under the requirements of the law. It would in fact employ subcontractors (the NSATC membership) to bid on annual NSAC issued RPP's and RBDP's. Unlike the original ARDEC interpretation model, the SPE would negotiate directly with the USG after having first developed proposals with its subcontractors. The major advantage of this strategy was its endorsed compliance with the current law as interpreted by higher headquarters. The two potential major drawbacks to this approach were (1) the burdening of additional administrative costs to the USG/membership for support of SPE operations and (2) the loss of direct contract privities between members and the USG. The Industry segment of the NSAC's Executive Committee initiated exploration of this alternative toward the end of FY08 conducting multiple benchmarking activities to better assess the impact of this change in strategy.



FY08 also marked the beginning of the NSAC role to service the JSSAP Program Office's Tech Base Program. The Advanced Technology Objectives thrusts centered on identifying Advanced Fire Control and Enhanced Lethality concepts were advertised as the principal bid opportunity for the BAA solicitation. Over the next three years, repetitive solicitation against those two generic thrusts would serve to provide the JSSAP with a full spectrum assessment of viable alternative avenues of investigation in both of these areas.

During that period, the NSAC continued its strategy of providing maximum information flow and exchange within the community via membership meetings, web content and ad hoc initiatives. The Muddy Boots forum continued to enjoy widespread support and acclaim from membership as firms received first hand observations of hardware capabilities and potential emerging needs from war-fighters fresh from theatre experiences. As a supplement to that exchange forum, industry members from the Research Program Committee were also invited to participate in a JSSAP Futures Conference as a means of insinuating supplier-push influence into the Government's long term planning process. That conference sought to define a new series of research paradigms for long term exploitation driven mainly by technology advances and not necessarily field experiences. In short, FY08 saw a series of collaborative initiatives designed to canvass innovation from both relevant perspectives, field and the laboratory.

TOSA#	Member Firm	Total Standalone/Networked, Compact, Low Power, Image-fused Multi-Spectrum Sensor System for Target Acquisition, Tracking, and Fire Control	Total Funds Obligated
0029	Stevens Institute of Technology	7.62MM Lightweight Cartridges	\$ 444,380.83
0034	General Dynamics Ordnance	Laser Steering and Automated Target Tracking	\$ 365,505.31
0036	L-3 Communications Corporation	Advanced Fire Control	\$ 630,790.00
0037	AAI Corporation	Guided Projectile	\$ 241,049.44
0038	AAI Corporation	RWS Light Qualification and MIWS Dev.	\$ 1,848,860.00
0039	L-3 Communications Corporation		\$ 901,489.00

\*W15QKN-09-C-0116 also awarded during this timeframe to Penn State University under the title "Covert RF Sensor for location and tracking of defiladed human target for enhanced Lethality" was a FAR-based instrument. It is included here because the item was solicited via the same CBA focused NSAC solicitation.

### FY09 Program

FY 09 represented the fifth and final year of the inaugural Other Transaction Agreement between the Government and the NSATC. The fiscal obligation ceiling of \$25M would not be breached by the expiration of this five year term mainly stemming from the afore-mentioned perturbations of resource availability and acquisition process guideline re-interpretation. The FY09 solicitation's release again reflected the FAR based Broad Agency Announcement strategy originally implemented in FY08. This time however, there was no blanket OTA agreement provision to enact awards since the Picatinny Arsenal Acquisition Center had decided unilaterally to suspend the OTA in its entirety owing to non-NSAC related considerations. If NSATC members proposed an OTA style effort during this fiscal year, awards were to be made under *individually* executed OTA's with those specific entities on a one-by-one basis. That stipulation only served to further aggravate what had already become a lethargic and reactionary business process. Furthermore, some FY08 awards had been deferred until this new fiscal year increasing the workload while concomitantly delaying the overall execution of the technical program. In short, the life blood of the Center concept, the investigation of new small arms ideas and concepts again suffered significantly in this final year.

Based on that dire forecast, the NSAC decided to execute an off-load strategy for FY10 and some undetermined period in the future. Off-loading simply meant to find a new USG acquisition agent with free resources to provide dedicated procurement support. The winter 2008 members meeting had been held at FNMI in Columbia South Carolina in December of that year. One of the featured speakers, Deputy Director Jeannie Hodges of the Army's new Contracting Command, provided a brief which added impetus to this offload decision. In short, Army Contracting had entered a "Perfect Storm" scenario since the advent of this nation's military entrance into Southwest Asia. Army provided a significant level of support during this period to support the nation's operations in its war against terrorism. This level of activity ran head-long into the advent of the baby-boomer generation retirement era. In short, diminishing expert procurement personnel levels arose just as operation tempos increased. The efforts by the new Command to address this "storm" provided a near term prognosis that did not offer much hope of relief in terms of cycle times and dedicated support. The Research Program Director, Mr. Frank Puzycki, accordingly acted to find alternative procurement agencies to create the next OTA instrument and to support associated procurement activities, at least on an interim basis. Contacts to some other services proved fruitless; however, the NSAC found a willing partner in the form of the Department of Interior's National Business Center (NBC), headquartered in Herndon VA.

The NBC had been established early in the Clinton Administration for precisely the purpose in which the NSAC now found itself. The NBC had been established as a leveraging agent to handle the Federal Government's contracting needs especially during surge periods in other agencies. A preliminary meeting in January 2009 established a potential win-win scenario between the two Federal agencies which was ultimately solidified through negotiations between both parties in the winter and spring of that year. ARDEC's management provided a final endorsement in April 2009 leading to the formal execution of a partnering agreement and new interim three year OTA by July 2009. While not a subject of this present report, the FY10 RPP was released by the NBC in September of 2009 re-establishing the much sought after predictable business calendar for NSAC/NSATC operations.

FY08/09 awards did occur under the extant OTA during the latter portions of FY09, chiefly focused on exhausting the technical state-of-the-art possibilities for the two Advanced Technology Objective Areas of Advanced Fire Control and Enhanced Lethality. Those awards, coupled to the incremental funding of prior FY08 awarded efforts, exhausted the supply of funds for that current year. The completion of this award activity served to provide the JSSAP with what could be termed a highly credible benchmark assessment of high technology avenues for both of those User-capability-driven ATO areas of interest. From that perspective, the five year OTA can be considered an unqualified success.

As noted in multiple prior sections of this report, two-way information exchange between the USG and Industrial base partners has been considered a foundational pillar of this organizational construct. The investment of time in establishing, nurturing and maturing this process was theorized from the outset to pay long term dividends in the form of more ambitious and responsive proposals for Joint Service consideration and implementation. Both member meetings and the website served as the principal extraordinary channels to achieve this end, supplementing the established RPP and RBDP processes and to a lesser extent, the annual call for White Papers. This White Paper solicitation had experienced an interesting evolution in the first five year history (FY06 did not generate a solicitation) of this process. While the quality of the papers seemed to improve on each successive cycle, the quantity of papers diminished from a high of 29 in its inaugural year to as low as 18 in the latter years. Clearly, some form of motivation and incentive was required to re-invigorate this long-term view planning input.



One of the industry members of the NSAC Research Program Committee, Mr. Eric Brisbon, proffered the suggestion that we afford "face-time" (with the key Product Management Office heads) to the very best papers received each year as a means to generate not only enhanced interest, but possible real time funded programs. This suggestion was adopted and implemented for the first time at Picatinny on 16 February 2009. The Product Managers for PM Solider Weapons, JSSAP and PM Maneuver Ammunition Systems met with the creators of the top eleven papers of 2009, as judged by the Research Program committee and its commodity specific subcommittees. The event proved to be an unqualified success as measured by both entrance and exit interviews with members and the PM community responses as a whole. As a further testimonial to that success, all three USG offices readily agreed to participate in FY10 as well!

Member meetings were held in both Columbia South Carolina (December 2008) and Fort Benning GA (June 2009). As noted before, guest speakers included the Infantry Center DCD, LTC Tom Henthorn of the Infantry center's Small Arms Division, Jeanie Hodges of the Army's Contracting Command and a host of other subject matter experts. The Muddy Boots sessions continued to spur dialogue between the War-fighter and industry communities. For the first time, the Infantry Center shared direct solider evaluations of key small arms systems with their respective authorized OEM product manager representative further enhancing field to producer information exchange. Clearly, momentum had been established and had taken deep root traced back to the pivotal decision to orchestrate the Muddy boots sessions in 2007!

TOSA#	Member Firm	Total	Total Funds Obligated
W15QKN-09-9-0003	Polymer	M249 Hardpack Magazine	\$336,824.30
W15QKN-09-9-0005	L3 Brashear	Improve Laser Steering and Automated Tracking capabilities	\$2,846,840.11
W15QKN-09-9-0006	Stevens Inst. of Tech	Develop an efficient, low cost, low power, multi-wavelength imaging and sensing system for fire	\$1,921,398.69
W15QKN-09-9-0007	GD-OTS Canada	5.56mm Blank Cartridges	\$324,156.12
W15QKN-09-9-0008	IAI	Automated Target Tracking Laser Range Finder for Small Arms TA/FC	\$250,564
W15QKN-09-9-0009	Dindl	Dynamically Reshaped Fragmenting Warhead	\$147,607.00
W15QKN-09-9-0010	Metal Storm	Directional Fragmentation and Advanced Fuzing	\$514,709

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